



# RE Technology Options for Electricity Generation


Where are the markets for relative competitiveness?

*Albrecht Kaupp*





## Issues asked to comment on

- Solar thermal CSP versus PV, Wind and 
- **Competitiveness** of PV, CSP and wind power plant State-of-the Art technologies.
- Development of renewable energy technology **prices**
- **Risk** assessment for technology options



**of the electricity power plant gate prices among those 3 major RE technology system groups CSP, PV, Wind . The gap will not be easily narrowed since all 3 continue with technology improvements**



Technology improvements are most likely if power plant operators earn a high enough return to invest in optimization and testing cutting-edge-technology improvements in the field.

**CSP** is not a “commercialized” technology just because somebody built the first CSP block at the Cramer junction in the USA 28 years ago. Higher returns to put more money into R&D are necessary to more quickly advance the technology.



3200 kWh/kW



x 2 =

1700 kWh/kW



x 1.7 =

2100 kWh/kW



no storage yield

WIND = ~ **7** ¢ / kWhPV = ~ **14** ¢ / kWhCSP = ~ **24** ¢ / kWh**IF**

- ❖ Each technology is build at a “**good location**”, and
- ❖ Each technology enjoys the same financial conditions, and
- ❖ Each technology has the same perceived or real risks, but
- ❖ Electricity buyers will value the “**quality**” of the electricity.



Wind

PV

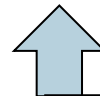
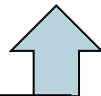
CSP



$\times < 2 =$



$\times 1.5 =$

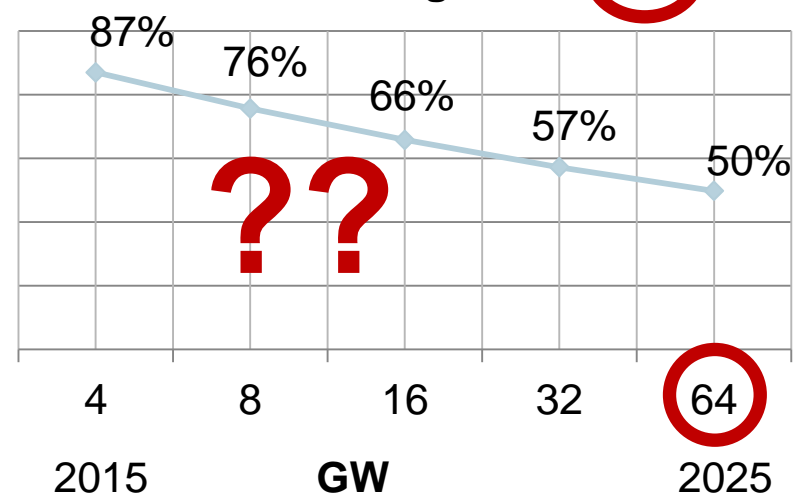


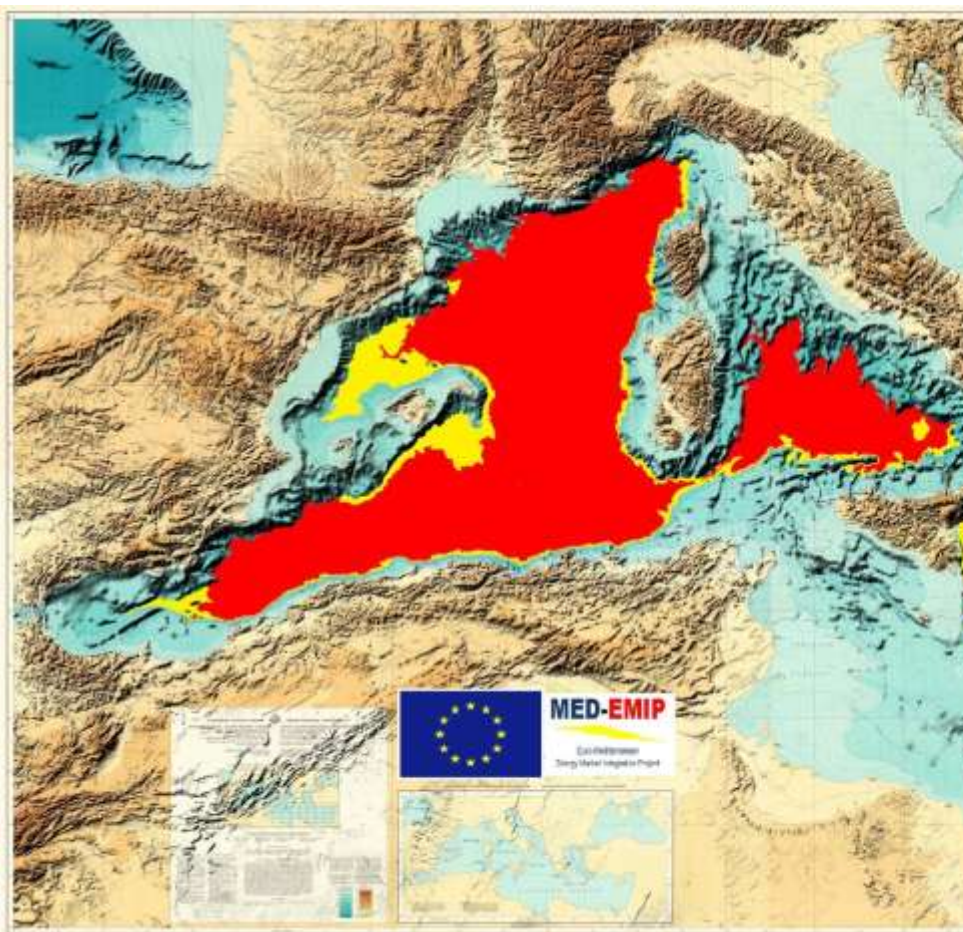
- Net yield kWh difference may change
- Investment cost per kW in favor of PV



Factor **2** will be challenged by PV and may drop to **1.5** due to faster falling PV system costs.

CSP Learning curve **15%**





**Electricity export by submarine cable into the EU is only realistic for the left shown 4 countries of Morocco, Algeria, Tunisia, Libya .**

**Challenges due to sea depth and steep coast lines will remain for many years to come for Egypt, Israel, Syria, occupied Palestinian Territories and Lebanon.**

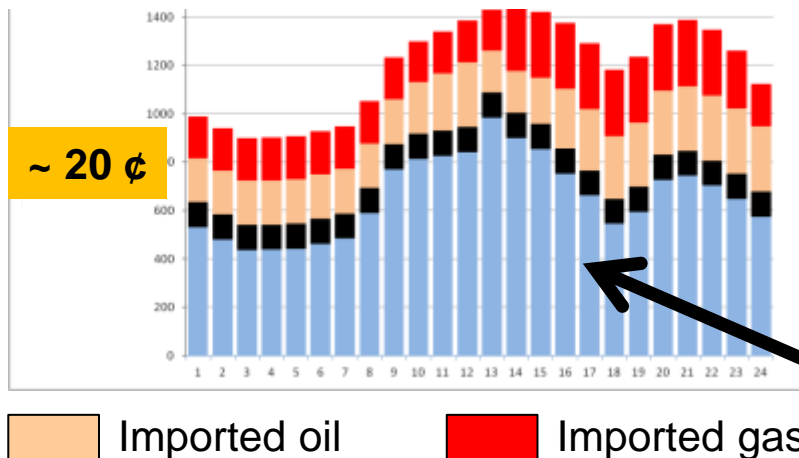
**Terrestrial path through Turkey and Bosphorus may not find a electricity buyer .**



**All** RE-based electricity generation is already financially competitive in the region if promoters we would minimize the practice of

- Selecting the wrong technology, or
- Putting it into the wrong places, or
- Operating it in the wrong application setting

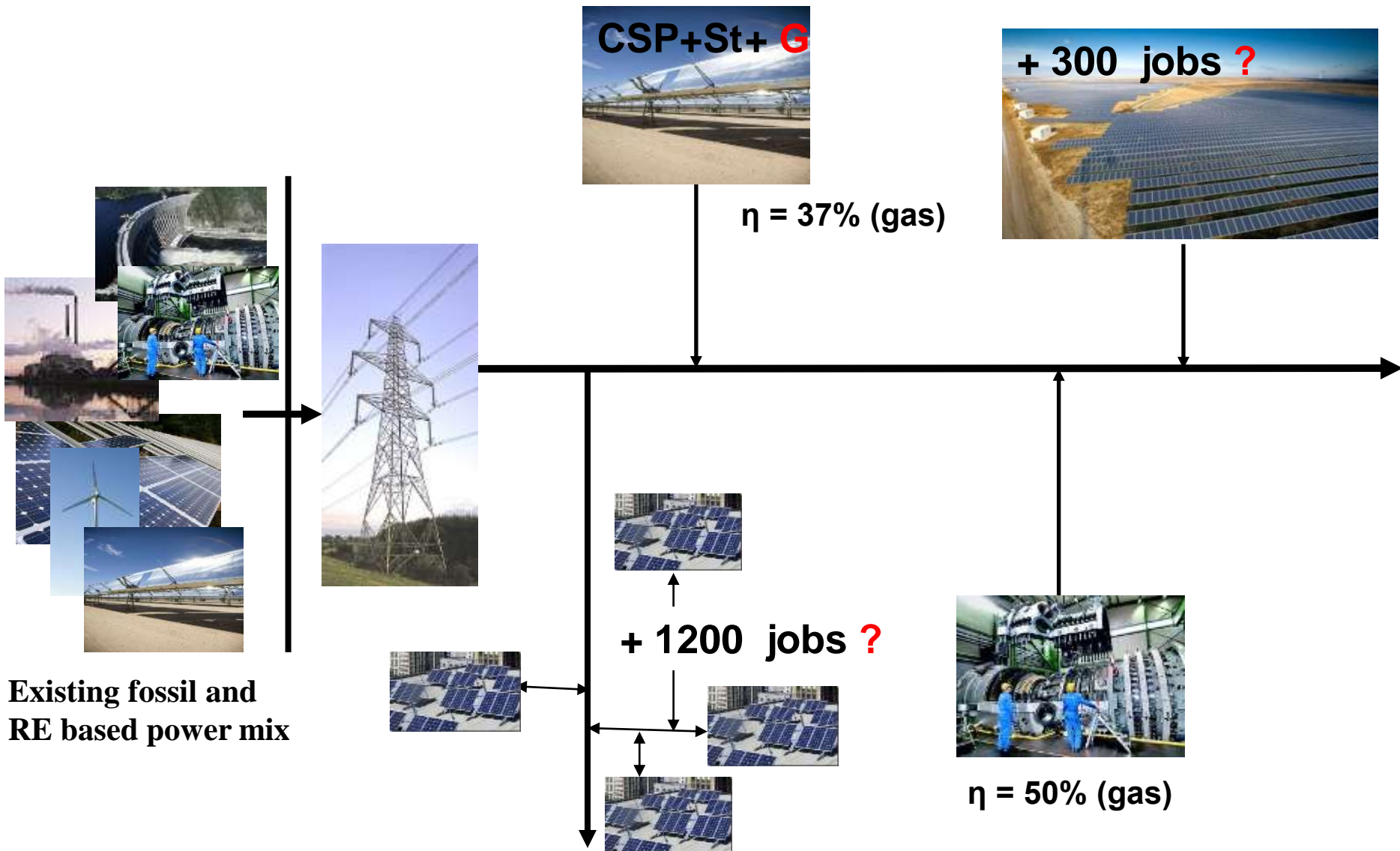
24 hour merit order of fuel usage



The better project scenarios are power utilities and countries that.....

- Burn 24 hours a day oil and gas
- Import this oil and gas.
- Government pays “market” prices for imported oil and gas.

More charts with more details are needed

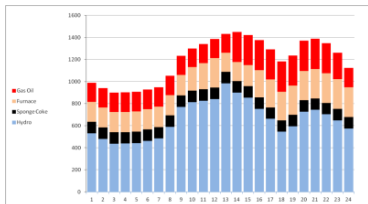




Technology	Rating	Firm Power (MW)
Public G+T+D System (all units)	10	YES
Coal fired thermal	9	YES
CCGT ( usually dual ready gas+oil)	9	YES
CSP+ Storage + <b><u>Captive</u></b> Gas or Oil	8 - 9	YES
CSP + Storage (0 % gas and 0 % oil)	5	YES
Hydro power (run off the river or dam)	2-7	YES
PV centralized	2-3	<b>NO</b>
PV distributed (MW(f) << MW(n))	3	YES
Wind + PV (hybrid)	3 - 4	<b>NO</b>
Wind	3	<b>NO</b>

“Firm” power defined as  $MW(firm) < MW(nominal)$  guaranteed for agreed period of time minus forced unplanned outage hours in %.

SAIDI - System average interruption duration index = SAIFI x CAIDI, inclusive of both controllable and uncontrollable events  
 SAIFI – System Average Interruption Frequency Index, CAIDI – Customer Average Interruption Duration Index



Identify more cases for stand alone fossil fuel saver RE power plants replacing imported gas+ oil in the merit order. They are cost effective no matter what test is used.



Building CSP power plants with storage able to deliver “firm” power, but selling this electricity on the spot market underutilizes the competitive advantage of “firm” power.



A CSP power plants with storage plus **captive** gas firing unit demonstrates lack of oversight how this unit could be integrated into the entire system



PV + Wind hybrids are a highly cost competitive RE solutions if there is an area/region with “**good**” conditions for both. It is however not “firm” power.



**Versus**



Distributed PV versus large central PV for all those who prefer economic value addition over investors’ financial gains ?